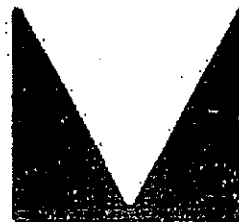


# Exhibit B

**GENERAL MOTORS CORPORATION**  
**MILFORD PROVING GROUNDS**  
**WATER SUPPLY STUDY**

**McNAMEE**  
**PORTER & SEELEY**  
**ENGINEERS ARCHITECTS**



**GENERAL MOTORS CORPORATION  
MILFORD PROVING GROUNDS  
WATER SUPPLY STUDY**

Prepared by

**McNamee, Porter and Seeley  
Engineers/Architects  
Ann Arbor, Michigan**

**June 1985**

## **SUMMARY, CONCLUSIONS AND RECOMMENDATIONS**

### **SUMMARY**

The staff at the General Motors Corporation's Milford Proving Grounds has expressed concern over their groundwater supply. Planned expansion at the proving grounds will cause increased demands, and the chloride content in the existing supply is of concern. This report addresses both of these issues.

The existing water consumption and future demands are assessed in relationship to the existing facilities. A location for a new supply well is investigated. The source and extent of the chloride is studied, along with other water quality concerns. A work plan is presented for Phase II efforts to determine the exact location of a new well.

### **CONCLUSIONS**

1. A new production well is needed at the Proving Grounds. Wells 4A and 5 provide firm capacity during current maximum day demands but cannot provide for peak demand on maximum day due to inadequate storage. Future maximum day demands can not be met with the firm capacity of the existing wells.
2. The transmission main from Wells 4A and 5 to the main building area is not looped, allowing potential for loss of all supply during repairs.
4. The military area has good recharge because of groundwater inflow from the west, south and north. No information was obtained east of the proving grounds.
5. There is good potential for a well near the test well 72-3 location. This well is close to the proving grounds border, possible interference on off-site wells was not investigated. Three locations have been chosen for further investigation.
6. Chloride levels in the existing supply wells are mainly caused by road salt infiltration into the unconfined aquifer. It is not clear whether the levels will worsen or have reached steady-state.

## RECOMMENDATIONS

1. For increased water demands, a new well is needed. A program should be implemented to determine the best location for a new well taking into account potential capacity, water quality, isolation from contaminant sources, and preferred locations of General Motors representatives to fit into their development plans.
2. An evaluation should be completed on the interference of the new well on existing wells located on private property east of the Milford Proving Grounds and GM Milfords existing production wells.
3. A looped transmission system should be installed between the existing production wells, the new well, and the main building complex.
4. A remedial action plan should be developed to address the chloride contamination. It should include annual monitoring of chloride levels in wells, semi-annual monitoring of surface waters, and samples of Mann Creek during the spring snowmelt. Salt application rates should be reduced where possible. Stormwater drainage improvements should be considered if chloride levels rise.

### ACKNOWLEDGEMENT

We wish to acknowledge the assistance of Mr. Bill Hawkins, Plant Engineering Manager; Mr. John Neil and Mr. Art Neparts, Plant Engineering Department; and Mr. Frank Maccioni and Ms. Carol Everett, Power Plant Dept.

Appreciation is also expressed to Mr. Harry Brown, Brown Drilling Company, and Mr. Ervin Stahl and Mr. Rodney Huff, Layne-Northern Company, for information regarding the existing production wells at the Milford Proving Grounds.

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## INTRODUCTION

The General Motors Corporation authorized McNamee, Porter and Seeley to conduct an investigation into expanding water supply capabilities at their Milford, Michigan Proving Grounds facility. This action has been taken in response to limited existing well capacity, to assure long-term system reliability, and to assess groundwater quality concerns. This report contains Phase I of the investigation, problem definition. Phase II will address the location of a new production well and completing a loop of the water transmission mains.

This study includes an analysis of the existing water consumption and projections of future demands. The existing facilities are assessed in relation to demands.

A study of the surface and subsurface conditions is undertaken to find a location for a new production well. Well logs and pumping tests are analyzed. The influence of the proposed well is determined in regard to its effect on the other production wells.

The source and extent of chloride contamination is investigated. Recommendations are made for further monitoring of the chloride levels. Other water quality data are presented.

Estimated costs are presented for a new production well compared with additional storage.

A work plan is presented for Phase II, including cost estimates and time schedule.

## WATER SUPPLY

### EXISTING FACILITIES

The existing water supply system consists of two production wells located near the military building, two elevated water tanks located near the main complex, a single 10-inch transmission main from the military area to the main building complex, and a 10-inch main from the main complex to the Building 42 area. These facilities, through a system of distribution mains, serve the main building complex, the military area and the Building 42 area. See Figure 1 for the facilities layout.

Both production wells have been recently redeveloped. Another production well (Well 3), drilled in 1953, was a major supply source, but because of high chloride concentrations, it is now only used for emergency supply. Chloride contamination is discussed further in this report under the Groundwater Quality section.

The current capacities for the existing production wells are shown in Table 1.

Table 1  
Production Wells

<u>Well Number</u>	<u>Present Capacity (gpm)</u>	<u>Expected Capacity (gpm)</u>
4A	575	575
5	700	700
3*	500	500

\*Not available for domestic use due to high chlorides

The elevated storage tanks have a total capacity of 400,000 gallons. Table 2 summarizes the tank sizes, elevation, and available supply for domestic use.

FIGURE 1  
Water Supply Facilities and  
Well Locations

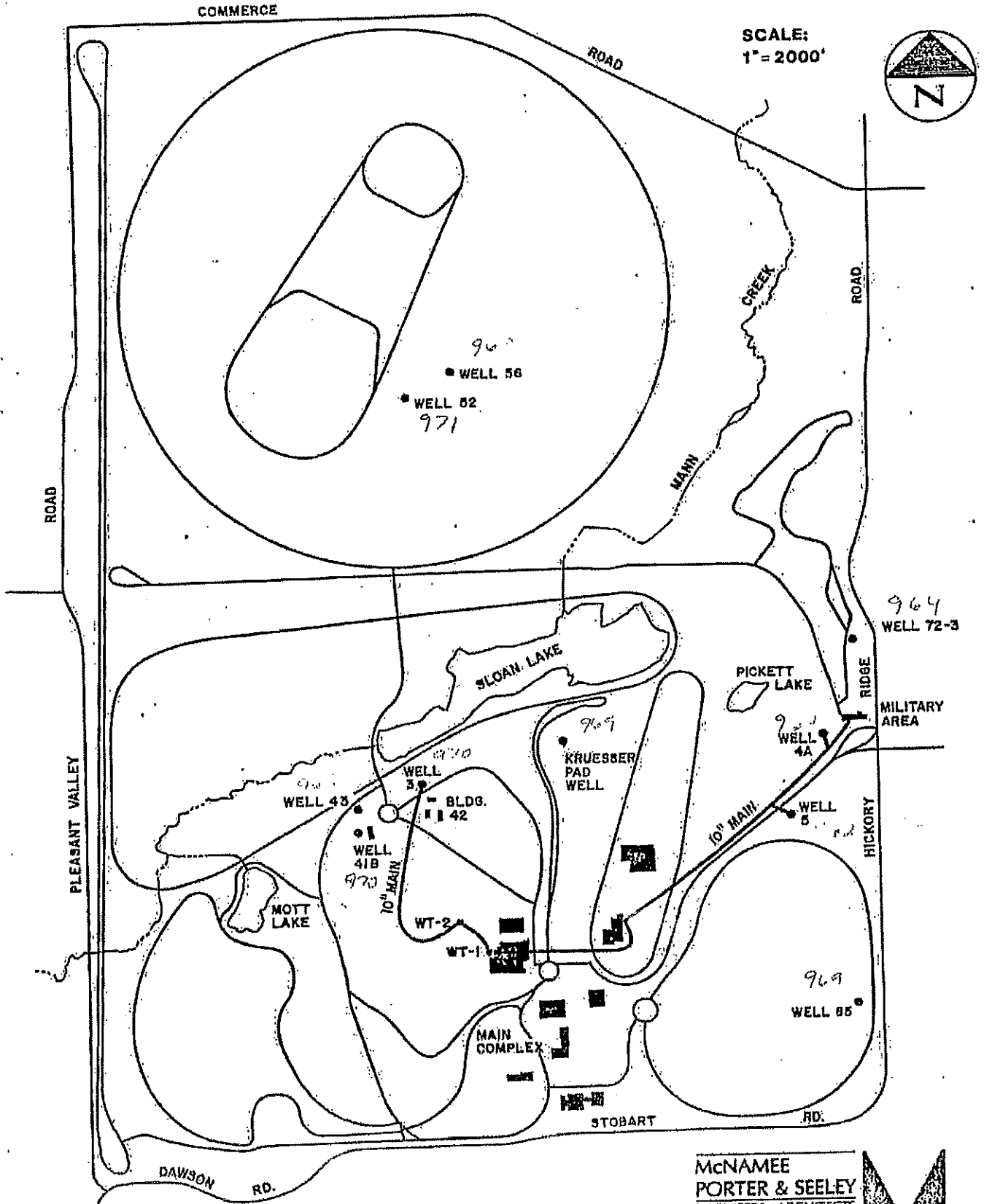


Table 2  
 Elevated Storage\*

Tank	Ground Elevation	Capacity (gallons)	Diameter (feet)	Domestic Operating Range	Domestic Capacity (gpm)
1	1189	150,000	28	1322 - 1313	41,000
2	1193	250,000	40	1324 - 1317	66,000
Total		400,000			107,000

\*Values obtained from General Motors Staff.

The remaining elevated storage of 293,000 gallons is reserved for fire flow. In addition, a 500,000 gallon underground tank with a 2000 gpm pump is used exclusively for fire flow.

Remote buildings not served by the main water supply facilities have their own small capacity wells.

#### EXISTING WATER SUPPLY REQUIREMENTS

Weekly pumping records for Wells 4A and 5 were analyzed for a one-year period from November 1983 to November 1984. Average daily demand was found to be 0.36 million gallons per day (mgd). This is equal to a continuous pumping rate of 250 gpm. Daily demand during the maximum week was found to be 0.49 mgd, and the maximum daily demand was estimated to be 0.72 mgd (500 gpm), utilizing a factor of 2 between average daily demand and maximum daily demand.

Storage facilities for domestic demand should be designed to handle the peak demands on the maximum day, with the average maximum day demand supplied by pumping. Assuming a sinusoidal demand curve during the maximum day, and a ratio of maximum hour to maximum day of approximately 2, the storage requirements would be equal to about 240,000 gallons. The existing domestic storage is equal to 107,000 gallons; therefore, the peak pumping demand is instead equal to 700 gpm.

The firm capacity of the production wells is currently 575 gpm after Well 5 redevelopment. Allowance should be made for decline in well capacity as previously experienced. If well maintenance and redeveloping is regularly implemented, the firm capacity should remain above 500 gpm. Firm capacity is defined as the system capacity with the largest well out of

## WELL EXPLORATION

### GEOLOGY AND HYDROLOGY

The General Motors Milford Proving Grounds covers approximately 4000 acres. The topography and geology is a result of the last stage of glaciation. The hilly, southern portion of the site resembles a terminal moraine. North of this, a glacial channel runs through the site, paralleling Mann Creek. The glacial deposits are in excess of 200 feet deep. Figure 2, taken from a USGS report titled "Water Resources of the Huron River Basin," shows the glacial channel and glacial thickness contours for the region. As is typical of glacial deposits, the subsurface conditions are variable, containing unsorted clay, silt, sand and gravel. The surface soils range from well-drained sands in the southern hilly area to poorly drained soils along Mann Creek.

Mann Creek drains the majority of the proving grounds, exiting near the southwest corner. Sloan Lake, the largest water body, was formed by damming up Mann Creek. There are many depression areas on the site with no outlets. The largest depression area is Pickett Lake, which has a fairly constant water level according to GM representatives. Pickett Lake has a water surface elevation of 985. Water surface elevations for Mann Creek range from 977 where it enters the proving grounds at Commerce Road, to 966 at Sloan Lake, then dropping to 946 at the outlet under Pleasant Valley Road.

### WELL LOG INFORMATION

Numerous wells have been drilled at the proving grounds. Logs from the wells provide two important pieces of information: 1) the soils variability with depth, and 2) the static groundwater level.

The well logs show a complex stratification of clay, sand and gravel. In both of the areas where there are many wells (the military area and Building 42 area), there are significant differences in the thickness and location of the clay and sand layers throughout the depth of drilling activities. The usable aquifer in the military area is at a depth of 80-120 feet and ranges in thickness between 30 and 60 feet.

Table 4 summarizes the available information on static water levels. The well locations can be found on Figure 1.

service. Well 5 currently has standby generating capacity, and Well 4A is expected to have reserve generating capacity in the near future. Portable electric generators are also available at the Milford Proving Grounds.

### **FUTURE WATER SUPPLY REQUIREMENTS**

New development at the proving grounds is expected to increase the building area from the present area of approximately 1.5 million square feet to about 2.25 million square feet, or a 50% increase. The water supply demands have been projected assuming a 50% increase in demand.

The average daily demand will be 0.54 mgd (375 gpm); the maximum daily demand will be 1.08 mgd (750 gpm); and the peak pumping demand based on the existing available storage will be 1200 gpm.

Table 3 summarizes the existing and future demands, pumping rates and storage requirements.

Table 3  
Water Demands and Storage

	Existing	Future
Average Daily Demand (mgd)	0.36	0.54
Maximum Daily Demand (mgd)	0.72	1.08
Maximum Daily Demand (gpm)	500	750
Peak Pumping Demand (gpm)*	700	1200
Production Wells Firm Capacity (gpm)	575	575
Required Storage (gallons)***	240,000	360,000

\*Capacity required to satisfy the peak demand with existing domestic storage.

\*\*Required storage to equalize peak demands on maximum day with pumpage rate equal to the average maximum day.

As shown in Table 3, if the available domestic storage were increased to 360,000 gallons, the firm capacity of the two production wells (575 gpm) would not meet the future maximum daily demand (750 gpm), at the full 50% increase in development. Because of this, a new well is the only viable alternative. The costs of added storage versus the cost of a new production well is presented in this report under Water System Alternatives for reference.





Table 4  
Static Water Levels\*

<u>Well Number</u>	<u>Year Measured</u>	<u>Static Water Elevation</u>
3	1953	970
4A	1983	964
5	1974	962
41B	1976	970
43	1976	968
Kruessem Pad	1974	969
52	1968	971
56	1978	969
65	1968	969
72-3	1972	964

\*Values obtained from General Motors staff.

From this information and surface water elevations, some conclusions can be drawn about groundwater flow directions.

1. A groundwater divide runs north-south through the Building 42 area.
2. Pickett Lake seems to be perched, meaning its water surface is above the general groundwater level in the area. This situation is usually caused by a continuous clay layer under the lake.
3. Groundwater flows towards the military area from the north, south and west. No information was obtained for private property east of the proving grounds.

#### **HISTORICAL PUMPING AND TESTS**

Well 4 was installed in 1964 and has been used as a production well since then. The pump test (see Appendix B) conducted in 1964 predicted a sustained yield of 1150 gpm. Once operational, considerable well losses made frequent redevelopment necessary. In 1975, a new well (Well 4A) was drilled next to Well 4 and is the current production well. Concurrently, GM staff conducted an investigation to locate a new production well. Test wells were drilled in

1969 and 1972. Two wells drilled near Well 4 in 1969 did not penetrate a usable aquifer, reaffirming the variability in this geologic deposit. In 1972, seven different test holes were drilled within 2000 feet of Building 12. Two of the holes again did not penetrate the aquifer. The other wells showed more promise. Two wells were located near the present Well 5. An aquifer test was conducted on December 17, 1972 by Brown Drilling Company. This test lasted six hours, pumping at a rate of 68 gpm. Yield at this location was estimated at 600 gpm.

Three other wells were located about 1000 feet north of the military building. On May 16 and 17, a 24-hour aquifer test was conducted by Brown Drilling Company of Howell. Well 72-3 was pumped at 290 gpm and two other wells used for observation; located 50 feet and 200 feet from the pumped well. Yield was estimated at 1000 gpm. The drawdown behavior during the test indicated that the aquifer was receiving recharge. The consultants, W. G. Keck and Associates, assumed that this was due to the drawdown cone encountering unconfined conditions, even though the well logs showed a confining layer. With more observation wells, and with some of their screens placed in higher formations, this could have been more accurately investigated. Typically, aquifer tests for unconfined aquifers should be run more than 24 hours; with 3 days being common to assess the influence of aquifer boundary conditions.

#### **RADIUS OF INFLUENCE**

Locating a production well near the Well 72-3 location has the following advantages:

- 1) The aquifer showed good potential in the June 1972 test.
- 2) The well receives groundwater recharge from three directions.
- 3) The well is close to the glacial channel (see Figure 2).
- 4) The well is near an existing transmission main.

From the above information, we have concluded that Well 72-3 is a good potential site for a new production well. Based on aquifer coefficients estimated by Keck, and observed

drawdowns, the influence of this well on the other production wells would be as follows:

<u>Pumping Rate (gpm)</u>	<u>Duration (days)</u>	<u>Drawdown at Well 4A (ft)</u>	<u>Drawdown at Well 5 (ft)</u>
312	1	3	2.5
312	100	6	5
625	1	6	5
625	100	11	10

This analysis used the Jacob Method, assuming no recharge (see Appendix E). The reduction in capacity of Well 4A or 5 with a production well at 72-3 pumping at 625 gpm would be approximately 10% for a 1-day duration and 20% for the 100-day duration.

Because of the fact that wells located east of the proving grounds could experience a reduction in capacity, and the 72-3 area receives heavy military traffic, three locations that fit in better with GM development plans have been chosen for further investigation.

#### ISOLATION

According to the Michigan Department of Health Act 399, Type IIa water supplies must be isolated 200 feet from storm and sanitary sewers, pipelines, septic tanks, drainfields, dry wells, cesspools, seepage pits, leaching beds, surface water, or other area from which contamination of the groundwater may occur. They must be located 2000 feet from any major source of potential contamination. Major sources include large scale waste disposal sites, land application of sanitary wastewater or sludges, sanitary landfills, and chemical or waste chemical storage or disposal facilities. Modifications may be authorized by the MDPH based on a hydrogeological study showing limited hydraulic connection between the contamination source and the well screen.

## GROUNDWATER QUALITY

### CHLORIDE CONTAMINATION

Concern has developed at the Milford Proving Grounds over increased levels of chloride in the production well supply over the past 10-15 years. In Well 3, the present chloride concentration is 600 milligrams per liter (mg/l), compared to the Environmental Protection Agency's National Secondary Drinking Water Regulations of 250 mg/l. Well 3 is not presently used for domestic supply.

Chloride concentrations at Well 4A (and previously Well 4) have increased from a level of 50 mg/l in 1967 to a present concentration of 200 mg/l. At Well 5, chloride has increased from 30 mg/l in 1974 when it was put into service, to a present concentration of 160 mg/l. In both Wells 4A and 5, the concentrations have remained steady since 1976.

Chloride concentration measurements have also been taken at Sloan, Mott and Pickett Lakes, Mann Creek, and at Wells 43, 56, 65 and the Kruesser Pad Well. These concentrations are shown in Table 5 for all the years of record.

There are four possible sources of the chlorides found in the production wells: 1) road salt used for ice control on paved roads, 2) calcium chloride used for dust control on dirt roads, 3) wastewater effluent, and 4) salt contained in geologic deposits.

#### Road Salt

Road salt appears to be a major source of chloride at the proving grounds. Approximately 10,000 tons of salt is used each year on the 120 miles of paved roads and parking lots. The salt drains off the roads and becomes part of the stormwater flow. The salt is readily dissolved into the stormwater.

Stormwater that enters the surface water drainage system that is tributary to Mann Creek leaves the proving grounds with the dissolved chloride. There is retention in Sloan Lake providing opportunities for the chloride to enter the groundwater system because of the groundwater gradient from Sloan Lake to the military area.

Table 5  
 Chloride Concentrations (mg/l)\*

Location	1967	1973	1974	1975	1976	1978	1980	1981	1982	1983	1984	1985
Well 3		350				200		485**		590**	600	
Well 4A	50	120		170	230	200		210			200	
Well 5			30	150	170	160		180			160	
Well 43								17			15	
Well 56								5			4	
Well 65								9			9	
Kruesser Pad Well							500				50	480
Mott Lake												
Mann Creek Entering Property							12		21	21	17	25
Mann Creek Leaving property						270	240		220**	260	300	240
Sloan Lake Outlet										150		
Pickett Lake							210				404	

\*Values obtained from General Motors staff  
 \*\*Average of two measurements

Some of the chloride-laden stormwater in the Mann Creek system does infiltrate into the ground before it reaches the creek. The amount of chloride that infiltrates by this process is lessened because the highest concentration storm flows are in the spring. At this time of year, the ground can be still frozen, eliminating infiltration.

The areas that provide a greater opportunity for chloride entering the groundwater are the depression areas. Stormwater tributary to these areas does not leave the site, and is therefore of greater concern. The Pickett Lake area (see Area B on Figure 3) is the largest depression area and includes runoff from roads and parking lots in the main complex and near the military buildings. Drainage Area C includes several depression areas north of the military area. Drainage Area D flows to a depression area just east of the proving grounds. There are also several smaller depression areas scattered about the Milford Proving Grounds. Drainage Area A is tributary to Sloan Lake. Table 6 summarizes the drainage areas.

Table 6  
Stormwater Drainage

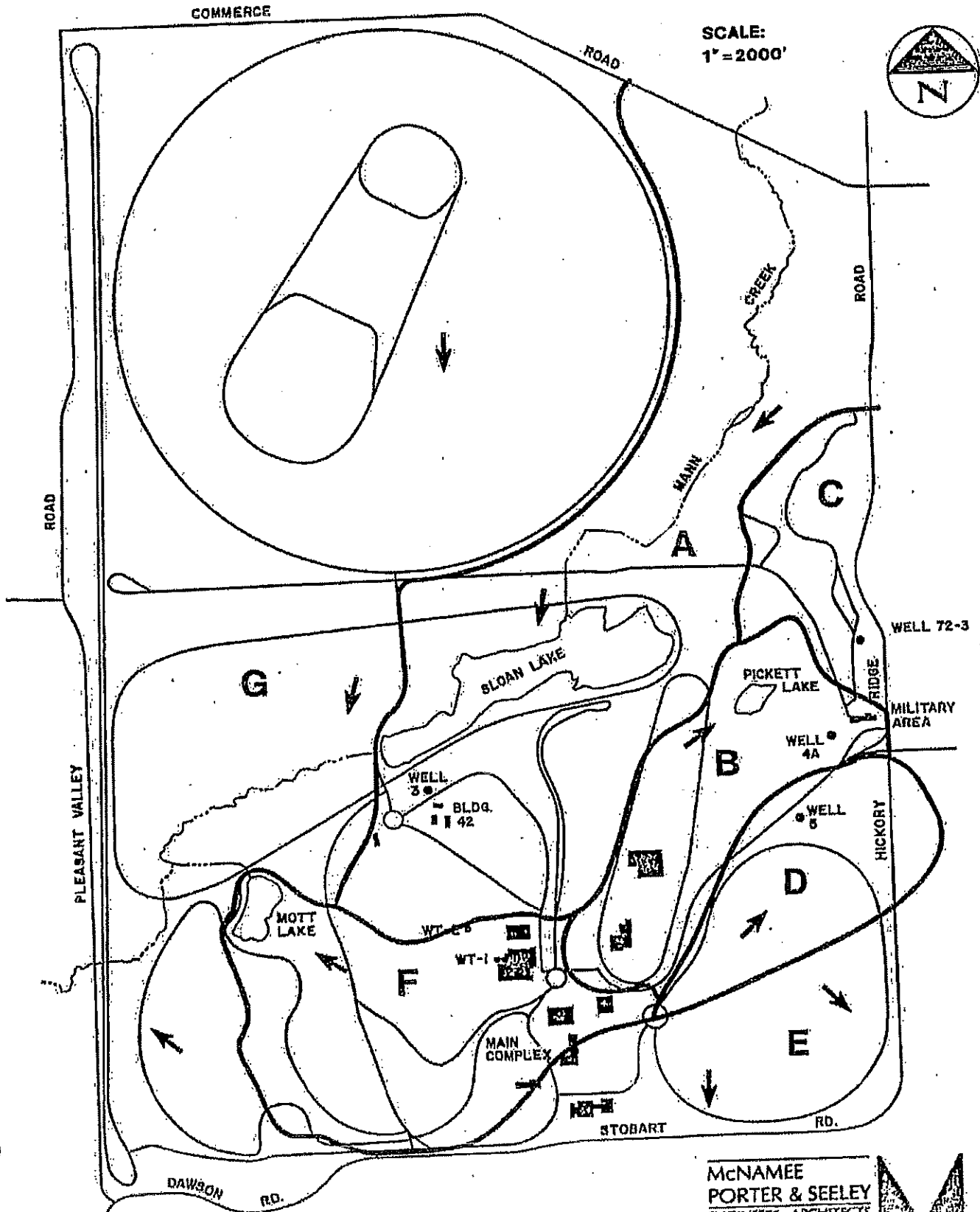
<u>Drainage Area</u>	<u>Area (acres)</u>	<u>Percent</u>	<u>Drains to:</u>
A	820	21	Sloan Lake
B	210	5	Pickett Lake
C	130	3	Retained On-site
D	90	3	Retained near site
E	320	8	Off-site
F	340	9	Mott Lake - Mann Creek
G	2000	51	Mann Creek
Total	3910	100	

Another possible source of well contamination is direct discharge of stormwater into the well along the casing.

#### Chloride Transport

Once entering the groundwater, contaminant transport is affected by advection, dispersion, and chemical reactions. Advection refers to the transport of the contaminants at the same speed as the average linear velocity of the groundwater as determined from Darcy's Law. Dispersion is caused by deviations from the average linear velocity which cause contaminants to spread both laterally and longitudinally. Chemical reactions include decay and adsorption, which both tend to slow the contaminants' transport.

FIGURE 3  
Stormwater Drainage



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Chloride is not affected by chemical reactions, and dispersion is small compared to advection. Therefore, we can assume that the chloride will travel in the same direction and speed as the groundwater.

Based on the available data, the approximate velocity of groundwater, and hence chloride, from the Building 42 area to the military area would be 100-ft./year. Therefore, the chloride contamination found in Well 3 would take about 50 years to reach the military area. This slow rate of travel focuses location of the source of the chloride in Wells 4A and 5 closer to the military area. Pumping tests indicated that the usable aquifer in the military area is not confined. Therefore, groundwater can migrate down to the lower aquifer. The drawdown caused by the wells will accelerate this process.

#### Calcium Chloride

Approximately 7 tons of chloride is applied on the dirt roads for dust control. Although this is a much smaller quantity than the salt applications, it is mainly used in the military area, close to the production wells.

#### Wastewater Effluent

The wastewater discharge into Mott Lake provides another source for chloride. Because of its location, this should not influence the chloride levels in the production wells.

#### Salt in Geologic Deposits

There is a possibility that there could be natural deposits of salt migrating toward the production wells due to the pumping.

#### Remedial Action

Monitoring of the chloride levels in wells and surface waters can further delineate both the extent and concentrations of the chloride plume. Based on the leveling off of chloride levels in production wells 4A and 5, it is possible that the concentrations have reached a steady level. Any new wells drilled at the site should be checked for contamination. Mann Creek should be monitored in the spring to determine how high the concentrations are during the peak salt-laden stormwater runoff. With this data, an estimate could be made of the total chloride leaving the proving grounds. Salt usage should be examined to determine if lesser amounts could be used, especially in those areas tributary to the military area.



# **WATER QUALITY**

Table 7 lists chemical analyses conducted at Wells 4A and 5 on September 13, 1984, along with the National Drinking Water Standards.

Table 7  
Production Well Water Quality\*

Contaminant	Well 4A	Well 5	Maximum Permissible Contaminant Level
Arsenic, mg/l	0.005	0.009	0.05
Barmium, mg/l	0.3	0.3	1.0
Cadmium, mg/l	0.01**	0.01	0.01
Chromium, mg/l	0.02**	0.02**	0.05
Lead, mg/l	0.05**	0.06	0.05
Mercury, mg/l	0.0005**	0.0005**	0.002
Selenium, mg/l	0.005**	0.005**	0.01
Silver, mg/l	0.02**	0.02**	0.05
Endrin, mg/l	0.0002**	0.0002*	0.0002
Lindane, mg/l	0.004**	0.004**	0.0044
Methoxyehlor, mg/l	0.1**	0.1**	0.1
Toxaphene, mg/l	0.005**	0.005*	0.005
2, 4-D, mg/l	0.1**	0.1**	0.1
2, 4, 5-TP, mg/l	0.01**	0.01**	0.01
			Recommended Concentration Limit
Chloride, mg/l	200	160	250
Color	10	30	15
Copper, mg/l	0.02**	0.02**	1.0
Iron, mg/l	1.0	1.9	0.3
Manganese, mg/l	0.02	0.04	0.05
Odor, Ton	0	0	3
pH	7.11	7.13	6.5 - 8.5
Sulfate, mg/l	37	37	250
TDS, mg/l	860	608	500
Zinc, mg/l	0.02**	0.54	5

NOTE: Recommended Concentration Limits for these constituents are mainly to provide acceptable aesthetic and taste characteristics.

\*Values from a Clow Corp. Analyses conducted on Sept. 13, 1984.

\*\*less than

## TREATMENT

The existing treatment at the Milford Proving Grounds consists of softeners and filters for sediment removal before entering boilers and cooling water systems. Manganese sand filters are used at remote wells for iron removals.

Centralized iron removal could be effectively accomplished through a combination of aeration (oxidation) and filtration. An elevated pH and sufficient detention time are critical elements to achieve desired finished water quality. Depending on the relative portions of ferric and ferrous iron present, the pH must be controlled in the range of 7.0 to 10.5 units. Pilot scale study should be conducted to identify the optimum pH conditions and establish chemical feed requirements. Sufficient detention time is necessary, following aeration, to complete the iron oxidation process. A 30-minute detention period is generally maintained to improve removal efficiency and provide consistent finished water quality.

Two aeration alternatives are available, pressure aeration and induced draft waterfall aeration. Pressure aerators are mounted in-line avoiding the need for double pumping. Their application is generally used for iron concentrations less than 1.5 ppm due to limited oxygen transfer capabilities. Close control of the air supply is essential to avoid "white water" conditions and increased corrosion potential. Pilot scale study is important with pressure aeration devices to insure treatment performance and reduce maintenance risks.

Induced draft waterfall aeration is currently practiced at many iron removal facilities. This approach transfers oxygen to the raw water using a cascade effect with air supplied by an induced draft fan. Several advantages are offered by this aeration process. Oxidation reactions are more efficient and dissolved oxygen is released prior to reaching the distribution system. Volatile organic compounds are effectively oxidized, reducing potential taste and odor concerns. Carbon dioxide and hydrogen sulfide gases, if present, are stripped from the raw water making the finished water supply less aggressive.

A detention tank should immediately follow the aeration step. A 30-minute contact time is recommended to insure complete oxidation of iron compounds present.

After filtration, finished water supply must be disinfected prior to reaching the domestic supply. Gas chlorination is the preferred method for both operational simplicity and initial capital cost investment.

A water softening plant can also be utilized to remove high iron contents from groundwater supplies. Treatment for softening generally includes lime addition, which raises the pH, thereby permitting the iron oxidation to be completed. The precipitated iron is coagulated with the lime added and a significant amount is settled prior to filtration.

Chlorides can be removed from water by anion exchange, or the physical process of evaporation or reverse osmosis. Typically, these alternatives are not cost-effective compared with finding an alternate source of water supply.

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## WATER SUPPLY ALTERNATIVES

### COST COMPARISON

Costs for a new production well are compared with the costs for added above-ground storage. The costs presented are based on an Engineering News Record (ENR) Index of 4200. The costs do not include engineering.

#### 16-inch Production Well\*\*

16-inch Boring and Casing 160-ft.	\$ 13,000
Well Development	4,000
Screen, Fittings, and Points	6,000
Test Pump Operations (3 day plus step test)	7,000
Pump (600 gpm)	30,000
10" Transmission Main (1000 ft.)*	30,000
Hydrogeological Report	5,000
Total	<u>\$ 95,000</u>

#### Storage Tank

260,000 gallons, 100-ft. high @ \$1.50/gallon	<u>\$390,000</u>
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\*Connection between the proposed well and existing transmission

\*\*The estimate of cost assumes a submersible pump and pitless adapter. Should a well house be required, an additional cost of \$60,000 can be expected.

## PHASE II LOCATION OF NEW PRODUCTION WELL

### OBJECTIVES

This investigation will identify the location for an additional production well. Three locations will be investigated (see Appendix F for letter and map showing locations preferred by GM Representatives).

- Inside Truck Loop
- Inside 7.2% Test Hill Loop
- Adjacent to Paddock Road

Site selection is to consider aquifer capacity, water quality and isolation from potential contaminant sources. The desired well capacity is 500 to 600 gpm, providing for capacity for the future peak pumping demands. Water quality consistent with Federal Primary and Secondary Drinking Water Standards is considered essential.

The following work plan is presented to outline the major elements for the Groundwater Exploration Phase. An estimate of cost and project schedule are also included to aid in General Motors Corporation planning efforts.

### WORK PLAN

1. Drill exploratory wells at each of the preferred sites using rotary methods. Holes should be 4-1/2-inch in diameter. Collect soil samples and complete analysis of water bearing formations.
2. Conduct electric and/or gamma ray logging at the exploratory wells to further define the potential of water bearing formations. Significant electric interference would favor the gamma ray logging method.
3. Complete the wells with 2-inch PVC casing and stainless steel screens to be used as permanent monitoring wells.
4. After well development, collect and analyze water samples from each exploratory well to assess conformance with Federal Primary and Secondary Drinking Water standards. Duplicate samples are proposed to improve data quality assurance.

5. From the initial data, complete an assessment of site potential and submit a recommendation of site selection for further testing.
6. Install a test well at the selected site to conduct test pumping. Either a 6-inch or 16-inch well will be installed depending on the degree of confidence for production well capability. The existing exploratory well will be utilized for observation purposes, and an additional 2-inch observation well will be installed to permit detailed water table monitoring necessary to assess aquifer potential.
7. After well development, conduct a step test to provide an initial determination of aquifer capacity and determine well screen losses.
8. Conduct a 3-day extended pumping test at design capacity to evaluate aquifer capacity and boundary conditions.
9. With the observed drawdown and recovery data, complete an evaluation of well capacity considering long term safe yield under a no recharge condition. Interferences from existing production wells will be evaluated.
10. Complete preliminary route selection for water supply transmission mains to connect with the existing distribution system. Consideration will also be given to complete the transmission main loop which would strengthen the supply reliability.
11. Prepare a written report summarizing our findings, conclusions and recommendations. The report would include the basis of design and opinion of construction costs for recommended improvements.
12. Prepare a detailed work plan and estimated cost for design (Phase III) and construction (Phase IV) of the production well, well house and transmission mains. We acknowledge that the well house may be excluded if submersible well pump design is desired.

### ESTIMATED COST

A summary of estimated costs is presented for the proposed work plan:

<u>Item</u>	<u>Estimated Cost</u>
Exploratory Wells (3 - 2")	\$ 13,000
Test Well (16")	34,000
Observation Well (2")	4,000
Laboratory Analysis	3,000
Engineering Investigation	<u>21,000</u>
Estimated Project Phase II Cost	\$ 75,000

We suggest that exploratory and test well work be awarded on the basis of formal quotations from licensed well drillers. Preparation of bidding documents and coordination of the work is included under our Engineering Investigation. Bidding documents would be prepared in accordance with General Motors Corporation purchasing requirements. These efforts would be included as subconsultant services under our engineering agreement.

An independent testing laboratory would be selected for the water quality analysis. These services will be arranged directly by our office. We would consult General Motors staff to determine the acceptability of the proposed testing laboratory.

A task oriented manpower estimate is included as Table 8 to indicate our expected level of effort for key personnel assigned to the project.

### PROJECT SCHEDULE

The Phase II Project Schedule is included as Table 9 to outline the relationship of each task. We suggest this phase be authorized prior to July 1, 1985 to enable construction completion during 1986.